Hazard Profile – Climate Change

Summary

- Impact on hazards – Climate Change is a phenomenon believed to be occurring globally. Scientific research and observational monitoring provides evidence that the earth is undergoing a warming trend that commenced during the past century. Based on scientific analysis, this phenomenon has the potential to affect several of our state's known hazards. This Summary will not be addressing the various hypotheses believed to be the causes of climate change, but will review data to illustrate how climate change has the potential to impact our region.

- Previous Occurrences – Climate change occurs over decades or longer time-scales. Until before the industrial revolution, changes in the global climate have been attributed to natural cycles occurring across centuries or millennia, because of continental drift, various astronomical cycles, variations in solar energy output or geophysical events such as volcanic eruptions. Over the past few decades however, many scientists have determined that it has become increasingly apparent that human actions have and continue to change the atmospheric composition, thereby contributing global climate change.

- Probability of Future Events – Through current scientific data and modeling, it is believed that climate change will continue to impact the earth. Determining the probability and severity of future impact is generally difficult to determine with any high degree of certainty due to the complexity of the interactions between factors involved and the fact that information gathered is continually evolving.

- Jurisdictions at Greatest Risk – This summary will not address any one specific jurisdiction or region in an attempt to determine risk as has been completed for other hazards within this plan update. The profile will only supply already existing information on how changes in the climate have the potential to affect our state's currently-assessed hazards. In some instances examples of potential impacts to specific areas are incorporated. It is important to note that in such instances, the analysis has been conducted by scientists and subject matter experts as referenced, and not by Emergency Management Staff.

- Special Note – It is beyond the scope of this hazard profile to synthesize a comprehensive overview of climate change, but rather, the intent is to increase awareness of the potential impact from this hazard. Therefore, this profile will not attempt to estimate potential losses, nor will it examine the potential causes of climate change. The fact that climate change is occurring is also not disputed. This profile will only provide information on the potential impacts climate change may have on some of our already existing hazards profiled within the SHMP. The Washington State Department of Ecology remains the primary source of information and subject matter experts for this hazard profile. This profile incorporates basic scientific findings and the most current projections for global climate change as they have the potential to impact the Pacific Northwest Region.

Introduction:

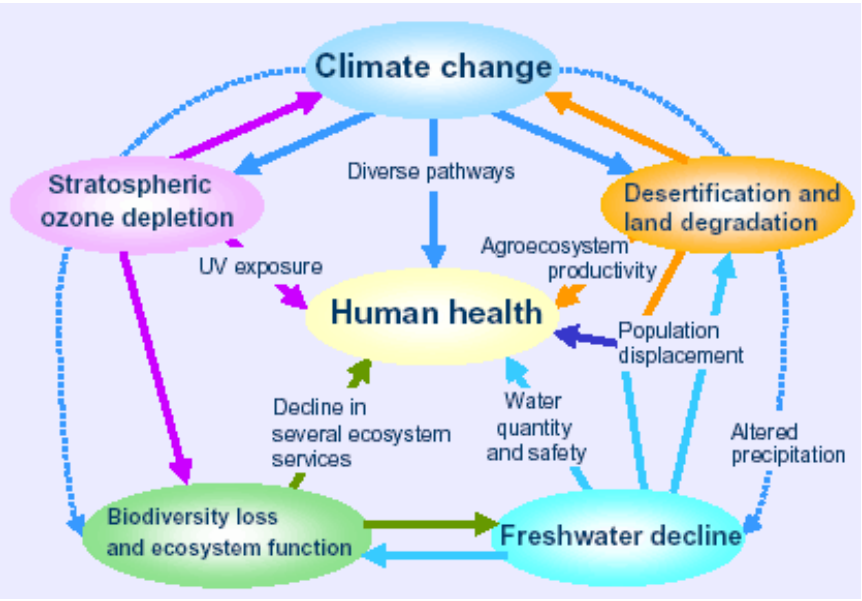
The Global Perspective – A General Overview[1]

In order to fully understand the potential implications associated with climate change, it is important that we first make the distinction between several different meteorological exposures: *weather, climate change and climate variability.* Weather is the continuously changing condition of the atmosphere, usually considered on a time scale that extends from minutes to weeks. Climate is the average state of the lower atmosphere, and the associated characteristics of the underlying land or water, in a particular region, usually spanning at least several years. Climate variability is the variation around the average climate, including seasonal variations and large-scale regional cycles in atmospheric and ocean circulations such as the El Niño/ Southern Oscillation (ENSO) or the North Atlantic Oscillation. The climate of a location is affected by numerous factors, such as latitude, altitude, vegetative cover, snow pack, hydrology and wind. Over time, climate changes both at a local level and a global level in response to ever-changing factors; it is a complex system response that has far reaching influences.

The impacts of climate change manifest at many geographic scales. It is an environmental hazard which can influence all areas necessary to maintain health. The depiction below from WHO illustrates the impact which climate change has on our ecosystem. These changes include hydrological systems, land degradation, among others and can interact with other large-scale geophysical phenomena such as ozone depletion.

The depiction brings an appreciation of the complexity of the systems upon which we depend, and also demonstrates the foundation upon which long-term health rely; the maintenance and continued stability and functioning of the biosphere's life-supporting systems.

FIGURE 1



Source: WHO "Global Environmental Change" available at: http://www.who.int/globalchange/environment/en/

According to a 2005 Governor's report prepared by the Climate Impacts Group titled *Uncertain Future: Climate Change and its Effects on Puget Sound*,[2] "[f]rom paleoclimatological evidence, we know that over the history of the earth high levels of greenhouse gas concentrations have correlated with, and to a large extent caused, significant warming to occur, with impacts generated on a global scale." While the report also indicates that the "ultimate impact of climate change on any individual species or ecosystem cannot be predicted with precision," there is no doubt that Washington's climate has demonstrated change.

Over the next 50 - 100 years, the potential exists for significant climate change impacts on Washington's coastal communities, forests, fisheries, agriculture, human health, and natural disasters. These impacts could potentially include increased annual temperatures, rising sea level, increased sea surface temperatures, more intense storms, and changes in precipitation patterns. Climate change also has the potential to impact the occurrence and intensity of natural disasters, potentially leading to additional hazards and significant economic losses.

Potential Impacts from Climate Change:
This section is not intended to address all potential impacts from climate change, but only bring to light examples of how climate change may impact the Pacific Northwest specifically.

Sea Level Rise:[3,4,5]

Coastal homes, roads, and infrastructure are at increased risk as sea level rises and storms potentially become more intense. Many of Washington State's cities and towns, as well as ports, tribal lands, businesses and residential developments are situated on or around the coasts of our state. Our coasts are home to some of the world's largest ports, and are of major significance to our tourism industry. Rising sea levels combined with possible increases in precipitation intensity will increase the risk of flooding, erosion and habitat loss along much of Washington's coastline.

According to the Thurston County Natural Hazards Mitigation Plan (2009), the City of Olympia's downtown region "faces the greatest threat from sea level rise as a significant portion of its urbanized waterfront lies only one to three feet above current highest high tides."

Drought:
Increased temperatures and changes in the hydrological cycle could lead to decrease in the frequency and amount of precipitation. Summer drought brought on by reductions in the amount of water stored as snow – coupled with higher temperatures will increasingly stress our existing forests, decreasing reproductively and tree growth in most low and mid-elevation forests. These changes will increase the infestation of exotic species better suited to a warmer environment. The current robustness of the mountain pine beetle is an example of this type of succession that will occur as the climate warms and the ecology changes. A series of cascading and associated affects will increase other risks, such as the risk of frequent wildland forest fires, which will in turn cause more landslides and an increase in water discharge and erosion as water travels over burnt ground.

Flood:
Increased temperatures and changes in the hydrological cycle could lead to increases in frequency and severity of flooding events. Likewise, areas which normally have not flooded have the potential for impact. Stormwater management, estuaries, watersheds (Salinization from tidal surges or damage to structures, etc.), power supply facilities - all have the potential for being impacted by increased flooding events.

Public Health: [6]
Climate change has the potential to be a significant and emerging threat to public health, and changes the way we must look at protecting the vulnerable populations which reside within the State of Washington. The potential impacts of climate change are not evenly distributed between populations; the young and the elderly are the most at-risk population. According to the WHO, "the impacts of climate change [globally] will also not be evenly distributed around the world. Climate variability and change cause death and disease through natural disasters, such as heatwaves, floods and droughts. In addition, many important diseases are highly sensitive to changing temperatures and precipitation. These include common vector-borne diseases such as malaria and dengue; as well as other major killers such as malnutrition and diarrhea."

According to the WHO, although global warming "may bring some localized benefits, such as fewer winter deaths in temperate climates and increased food production in certain areas, the overall health effects of a changing climate are likely to be overwhelmingly negative. Climate change affects the fundamental requirements for health – clean air, safe drinking water, sufficient food and secure shelter."

Snow Pack:[7,8]
The Northwest is highly dependent on temperature-sensitive springtime snowpack to meet growing, and often competing, water demands such as municipal and industrial uses, agricultural irrigation, hydropower production, navigation, recreation, and in-stream flows that protect aquatic ecosystems including threatened and endangered species. Higher cool season (October through March) temperatures cause more precipitation to fall as rain rather than snow and contribute to earlier snowmelt. April 1 snowpack, a key indicator of natural water storage available for the warm season, has already declined substantially throughout the region. During the past 40-70 years, the average decline in snowpack in the Cascade Mountains was about 25 percent. It is anticipated that further declines in will continue as a result of additional warming trends. It is anticipated that snowpack could potentially decline as much as 40 percent in the Cascades by the 2040s. Throughout the region, earlier snowmelt will cause a reduction in the amount of water available during the warm season. Figure 2 below demonstrates the changes between 1928 and 2000. The glacier has diminished to the point of leaving only a glacial lake in the place where a glacier once existed.

Figure 2: Comparison of South Cascade Glaciers – 1928 and 2000

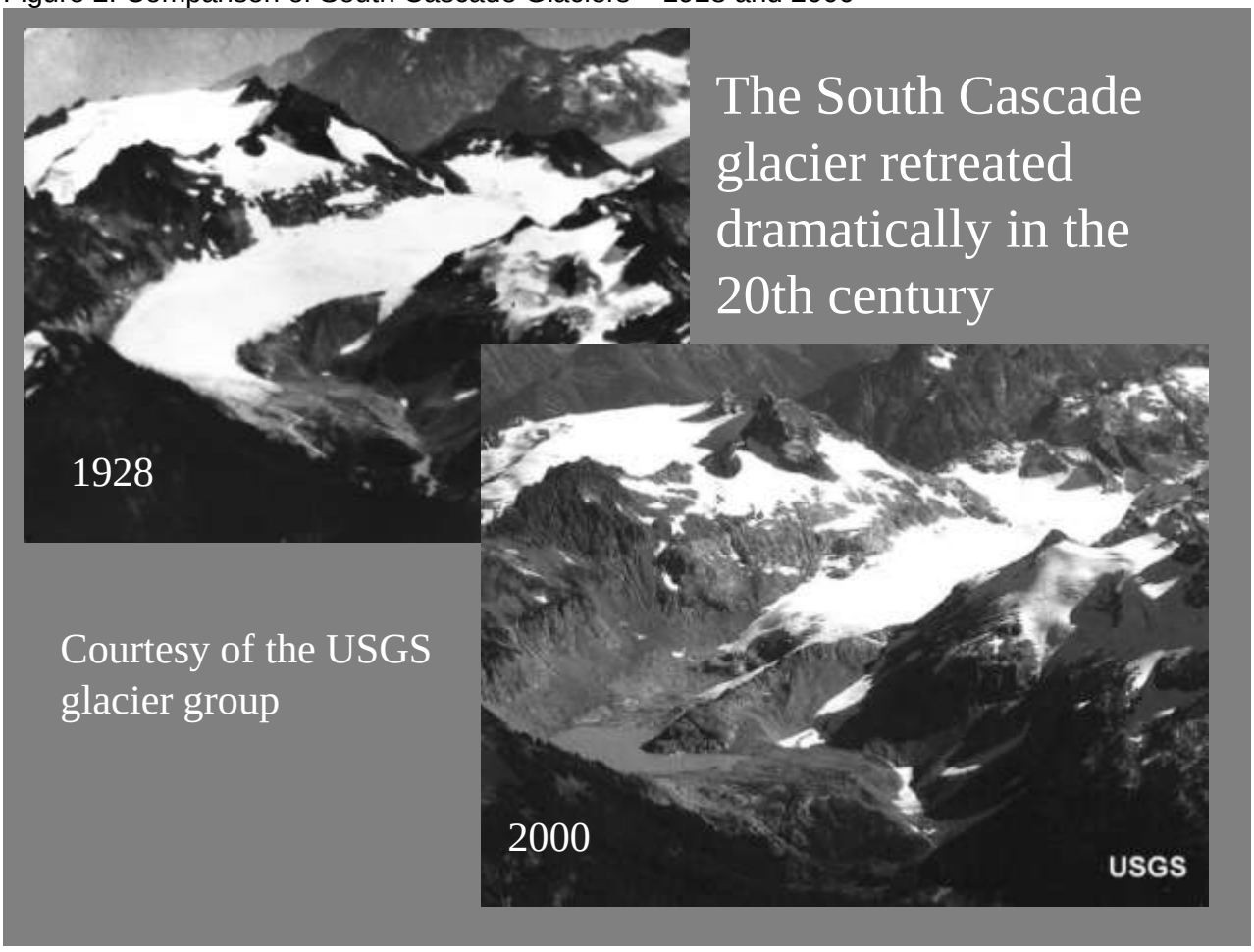
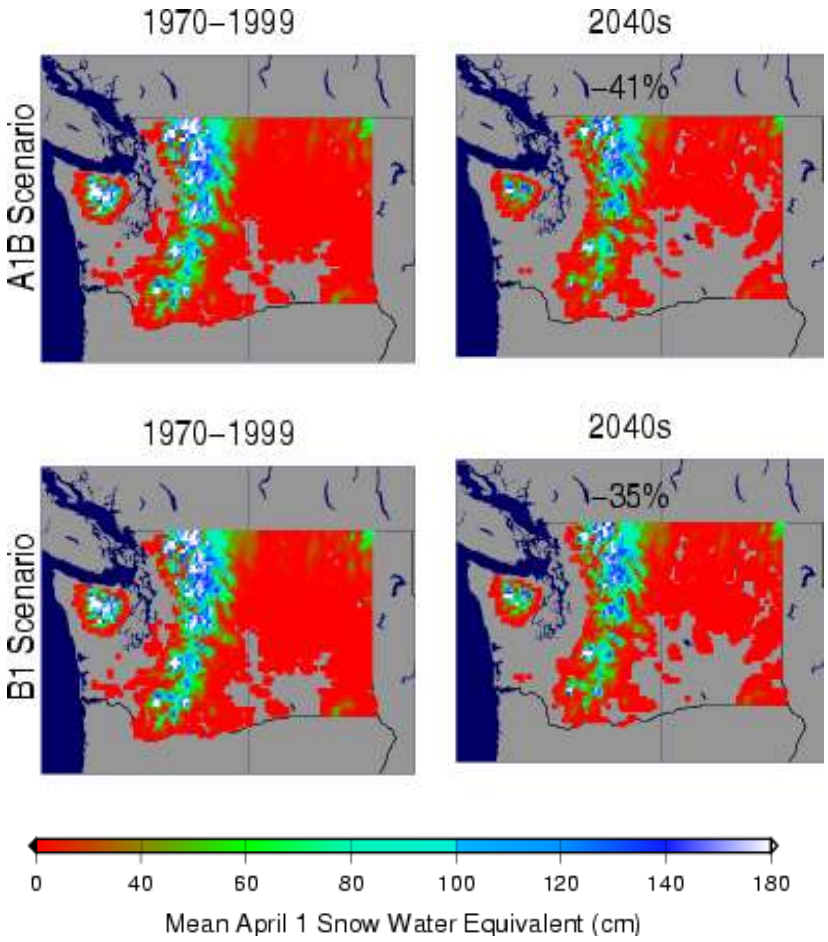


Figure 3 demonstrates the lowering spring snowpack from 1970 to 2040.



In areas within Washington which are accustomed to snow, a warmer climate can mean major changes in the timing of snow runoff and stream flow. A shift in the timing of stream flow has already been observed over the past 50 years, and is anticipated to continue, with runoff shifting 20 to 40 days earlier within this century. This, ultimately, also has the potential to impact our salmon runs.

Higher Temperatures and Secondary Hazards:[9,10]

The issue which the average citizen most routinely associates with climate change is the increase in temperature. In 2008, the Climate Impact Group, utilizing 20 global climate models, estimated the average warming rate in the Pacific Northwest during the next century to be in the range 0.1-0.6°C (0.2-1.0°F) per decade, with a best estimate of 0.3°C (0.5°F) per decade. For comparison, the warming trend for the 20th Century was 0.15°F per decade; the observed warming trend in the second half of the 20th Century was approximately 0.2°C (about 0.4°F) per decade. The graphic below demonstrates the project increases in temperature from 2000 to 2100.

FIGURE 4

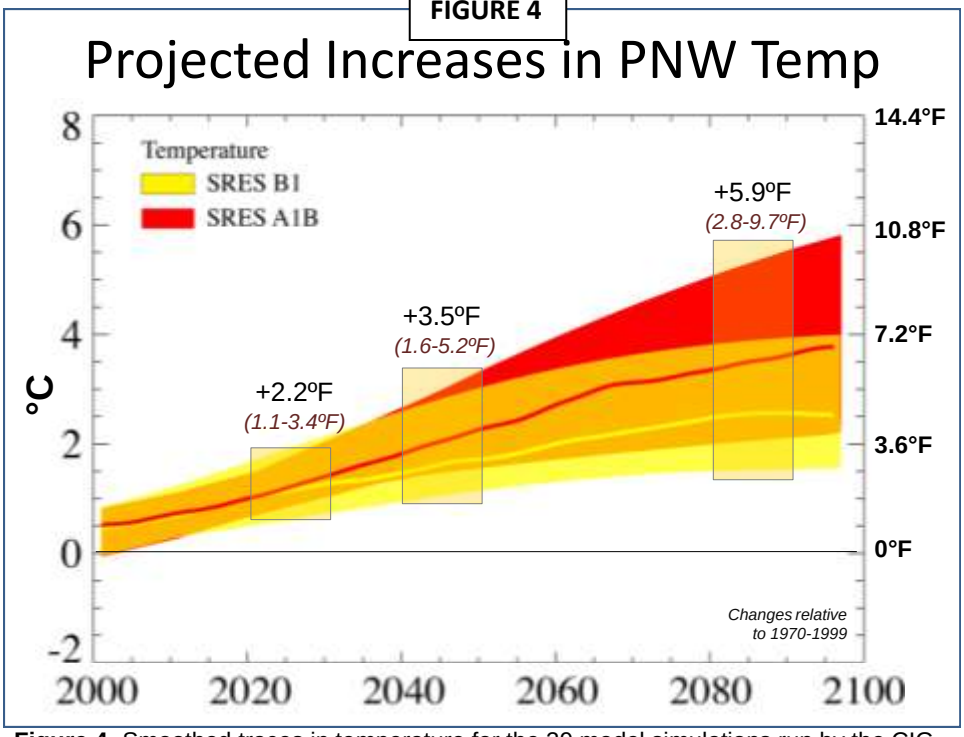


Figure 4: Smoothed traces in temperature for the 39 model simulations run by the CIG in 2008, relative to the 1970-99 mean. The smooth curve for each scenario is the Reliability Ensemble Average (REA) value, calculated for each year. The average provided above each box and in the table below is the REA for that decade; the low and high values represent the lowest and highest value from the two scenarios utilized for this model, which are described in detail at the end of this section.

While the temperature may potentially increase, that increase in temperature will also have additional impacts, such as: an increased insect outbreak, wildfires, and changing species composition in forests, which, ultimately will impact our ecosystems and the forest products.

Higher summer temperatures and earlier spring snowmelt are expected to increase the risk of forest fires by increasing summer moisture deficits; this pattern has already been observed in recent decades. Drought stress and higher temperatures will decrease tree growth in most low- and mid-elevation forests and will also increase the frequency and intensity of mountain pine beetle and other insect attacks, further increasing fire risk and reducing timber production, an important part of the regional economy.

This list of potential impacts is far reaching, and well beyond the scope of this hazard profile. More detailed information is available from the Washington State Department of Ecology, the State's subject matter experts on this issue.

Conclusion:
While the impact of climate change will vary by region and jurisdiction, scientists, insurers, investors, planners, designers, and policy makers must respond to the significant consequences of climate impacts on human health, coastal infrastructure, ecosystems, agriculture, and the economy. It is important that all levels of government and all sectors of society have at least a basic understanding of the potential impacts upon their region from climate change. Legislation is in place, reference RCWs 28B.50.273, 39.35, 43.41.130, 47.01.440, 70.94.151 and 161, 70.235, 70.260, 80.50, 80.58, 80.70, 80.80, which sets forth requirements to address the issue. Greater information on Washington's initiatives is also contained within the Loss Avoidance Study, Tab 9.

Scenario Development Methodology:

B1 and A1B scenarios:

- B1 scenario – The B1 scenario represents a more integrated and more ecologically friendly world characterized by:
  - Rapid economic growth but with rapid changes towards a service and information economy.
  - Population rising to 9 billion in 2050 then gradually declining to 7 billion by 2100.
  - Reductions in material intensity and the introduction of clean and resource efficient technologies.
  - An emphasis on global solutions to economic, social, and environmental stability.

- A1B scenario - The A1B scenarios also represents an integrated world characterized by:
  - A balanced emphasis on all energy sources (a mix of fossil fuels and clean energy technologies).
  - Very rapid economic growth with rapid introduction of new and more efficient technology.
  - Global population peaks at 9 billion in 2050; declines to 7 billion (2100).
  - Economic and cultural convergence and capacity building; substantial reduction in regional differences in per capita income.
  - People pursue personal wealth rather than environmental quality.

Note that A1B is a more “middle-of-the-road” scenario, not a worst case scenario.

[1] World Health Organization (WHO). "Climate Change and Health." Accessed 27 Feb. 2010. Available at: http://www.who.int/mediacentre/factsheets/fs266/en/index.html

[2] Snover, A.K., P.W. Mote, L. Whitely Binder, A.F. Hamlet, and N.J. Mantua. (2005) Uncertain Future: Climate Change and its Effects on Puget Sound. A report for the Puget Sound Action Team by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of Atmosphere and Oceans, University of Washington, Seattle).

[3] United States Global Change Research Project. (2009) Northwest Region. Cambridge University Press. Accessed: 5 April 2010. Available at: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report/regional-climate-change-impacts/northwest

[4] Thurston County Natural Hazards Mitigation Plan. (2009). P. 4.7-7

[5] United States Global Change Research Project. (2009) Northwest Region. Cambridge University Press. Accessed: 5 April 2010. Available at: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report/regional-climate-change-impacts/northwest

[6] World Health Organization (WHO). "Climate Change and Human Health." Accessed 27. Feb. 2010. Available at: http://www.who.int/globalchange/en/index.html

[7] United States Global Change Research Project. (2009) Northwest Region. Cambridge University Press. Accessed: 5 April 2010. Available at: http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/full-report/regional-climate-change-impacts/northwest

[8] Reeder, Spencer. Washington State Department of Ecology. Presentation to the Washington State Emergency Management Council. November 2008.

[9] Ibid.

[10] Reeder, Spencer. Washington State Department of Ecology. Presentation to the Washington State Emergency Management Council. November 2008.